A.8: Securing Sustainable Seas: Near Real-Time Monitoring and Prediction of Global Fishing Fleet Behavior

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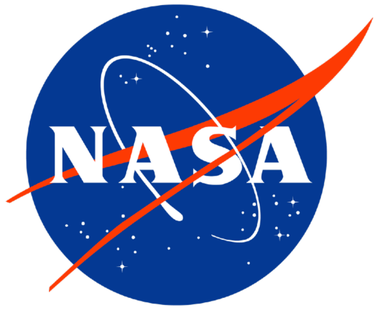


Issue: Sustainable Seas

Illegal Maritime Activities

TARGET 14.4.1

Effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield

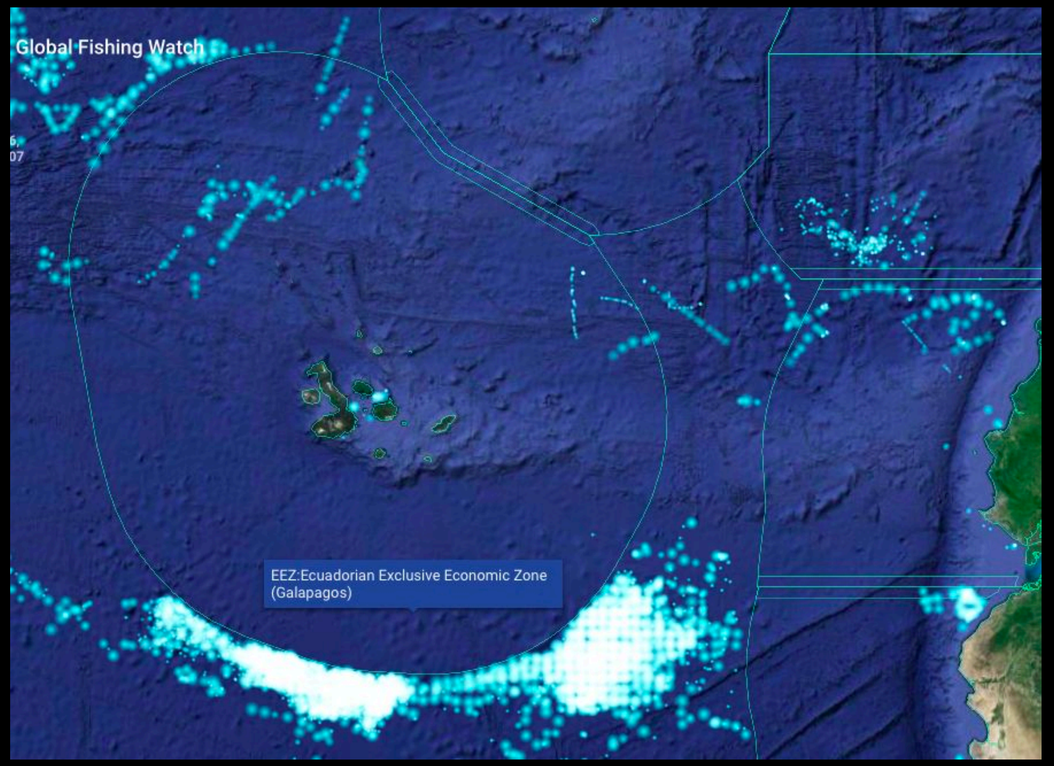
Issue: Sustainable Seas

Illegal Maritime Activities

Catching what you’re not supposed to

Issue: Sustainable Seas

Illegal Maritime Activities



Fishing where you're not meant to i.e. MPAs

GLOBAL FISHING WATCH

Issue: Sustainable Seas

Illegal Maritime Activities

Geopolitical tension can arise from international fishery disputes. In particular, the expansion and militarization of the Chinese fishing fleet

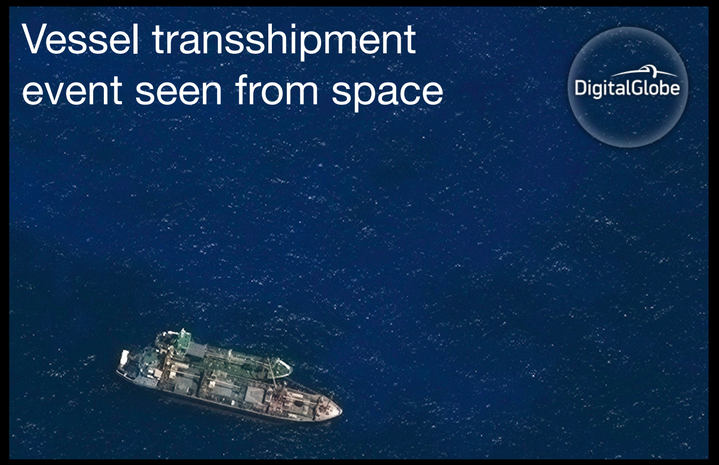
Issue: Sustainable Seas

Illegal Maritime Activities

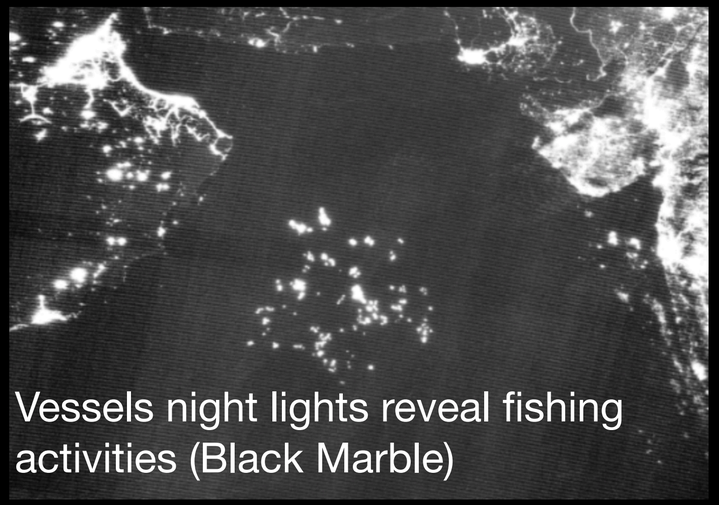
Indian Navy Seizes Drugs Worth $400 Million From Fishing Boat

The Challenge is that…

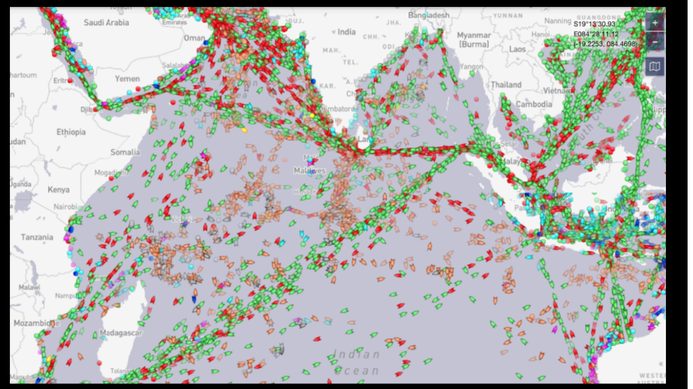
… illegal activities are difficult to detect



Vessels transmit their location via the Automated Identification System (AIS)



Vessels night lights reveal fishing activities (Black Marble)

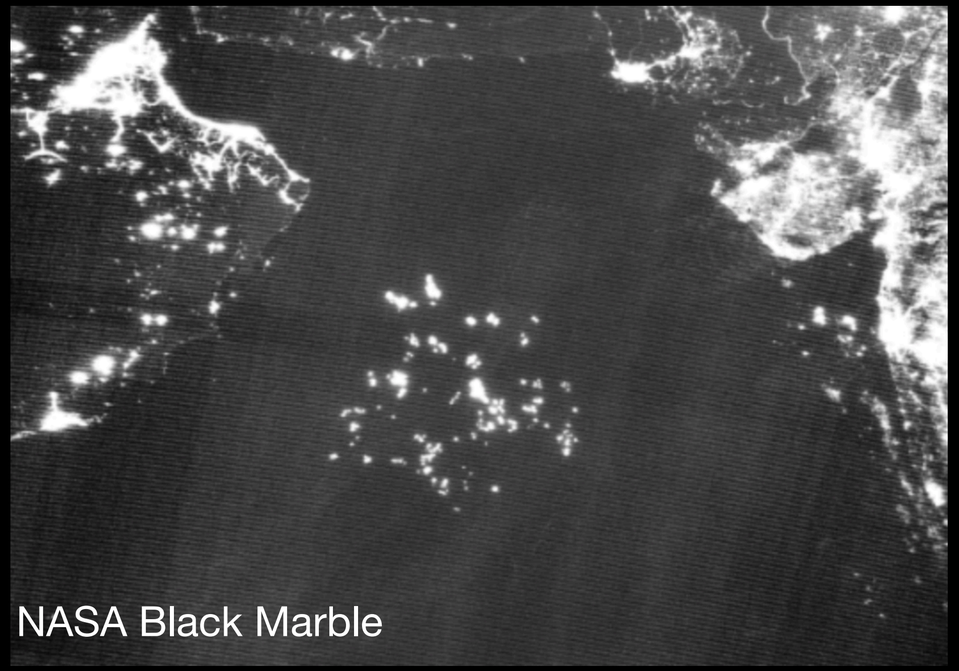


AIS data track the majority of the world's vessels

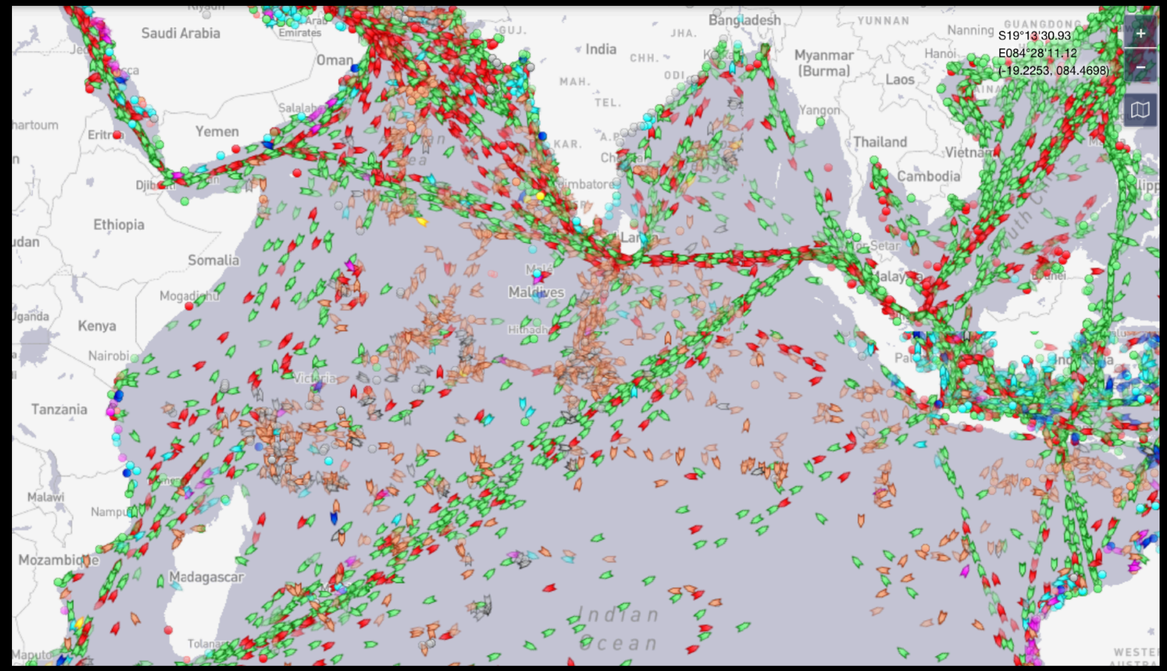
GLOBAL FISHING WATCH

Solutions

Counting vs Modeling



Suspicious grouping of fishing vessels in the Indian Ocean seen from their night lights

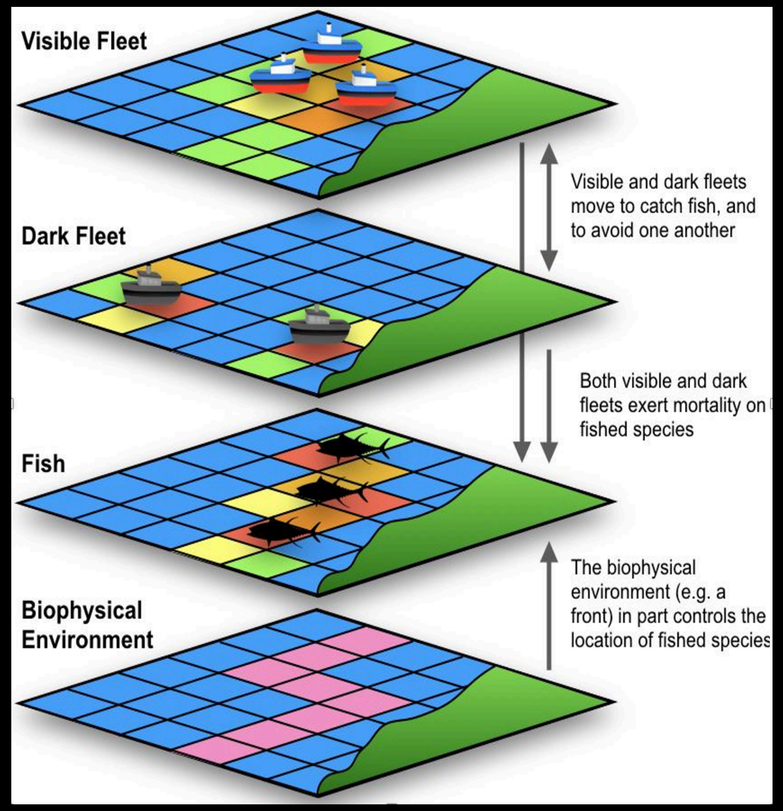


Disparity with the number of vessels in the area as seen from AIS data

GLOBAL FISHING WATCH AIS

Solutions

Counting vs Modeling



Observable fishing vessels (AIS, night lights)

Hidden vessels committing illegal activities

Hidden living marine resources

Observable biophysical environment (SST, Chl-a, Lagrangian Coherent Structures…etc)

GLOBAL FISHING WATCH

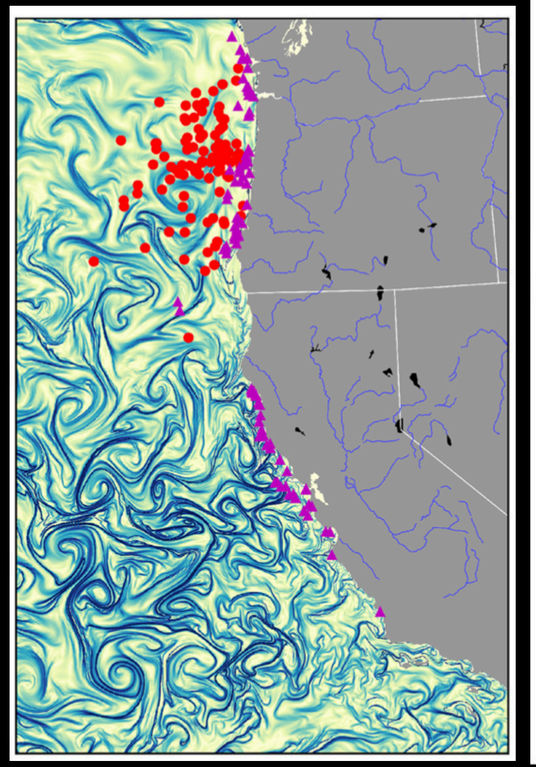
NASA

Solution 1: Fishing on Fronts

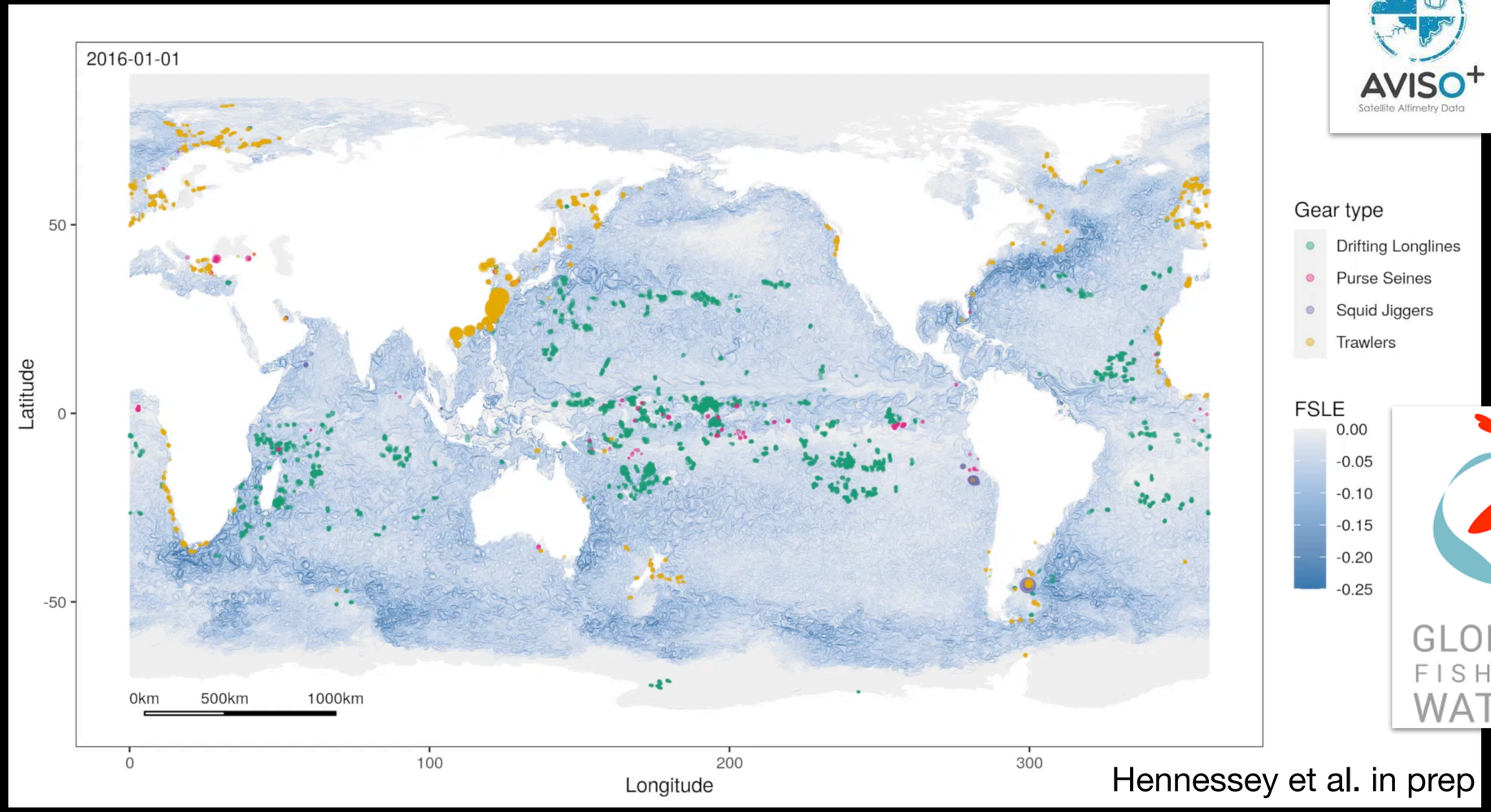
(Random or not? Fred Castruccio, NCAR)

Lagrangian Coherent Structures (fronts) and fishing

Random or not?



Watson et al. 2018



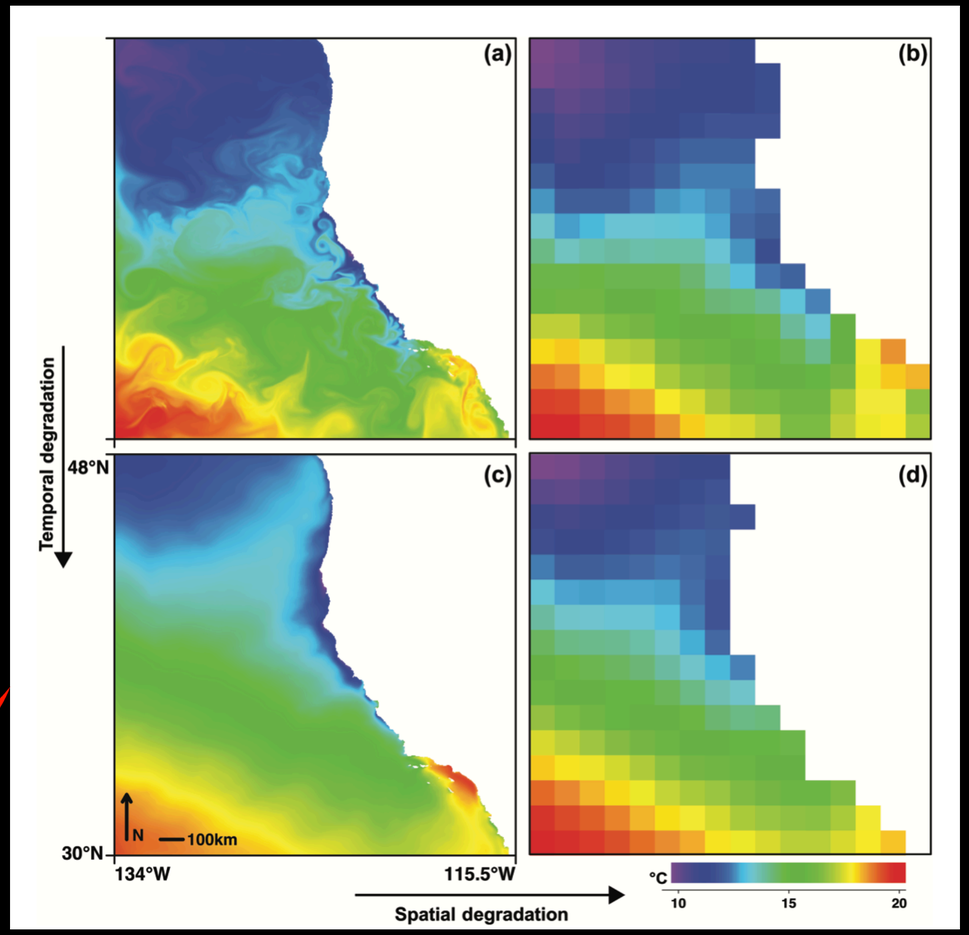
Hennessey et al. in prep

Solution 2 : Oceanographic Drivers of Fishing
(Scale Dependence!)

$$y = f(x, z...)$$

y = fishing
x = SST
z = Chl-a
…
f(..) is a neural network

MODIS derived
SST, Chl-a



Scales et al. 2016

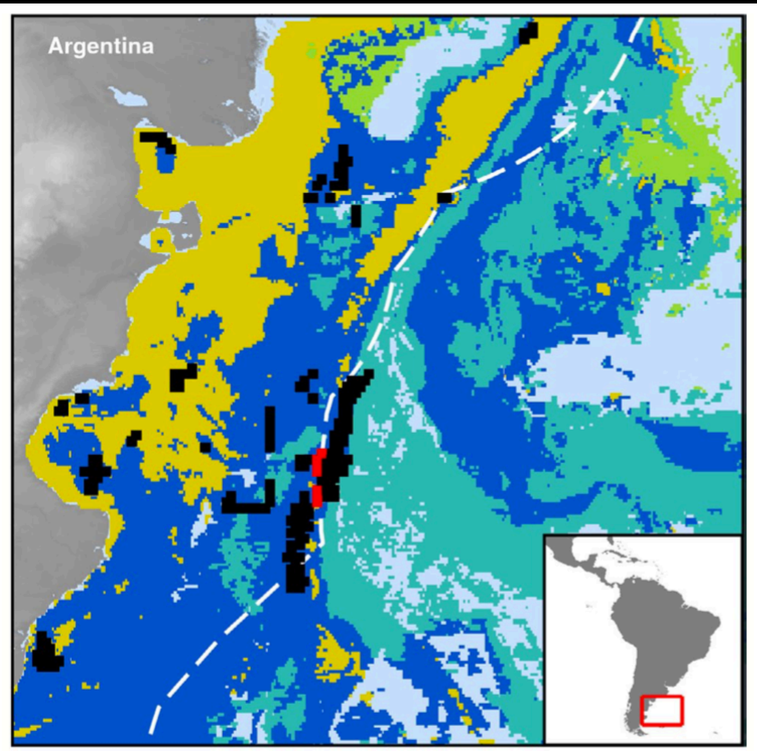
Oceanographic predictors of fishing at various time and spatial scales

Done regionally for large pelagic species; now we're doing this globally for the ocean's top predator (fishing). Martin et al. in prep

Solution 3: Drivers of Illegal Fishing

Ocean conditions predict when vessels cross borders

NASA seascapes
(M. Kavanaugh)



DWF Vessel in EEZ
Temperate Blooms Upwelling
Temperate Transition
Warm, Blooms, High Nuts
Other Vessel
Tropical Seas
Other

Argentina sinks Chinese trawler during pursuit for illegal fishing

Crew rescued, with Buenos Aires saying Lu Yan Yuan Yu 010 was trespassing in its waters, tried to ram coast guard boat and ignored warning shots

NASA seascape data combined with AIS and Machine Learning can predict when Chinese vessels are likely to enter the Argentine EEZ

Woodill et al. 2021

TABLE 3 Summary of main results

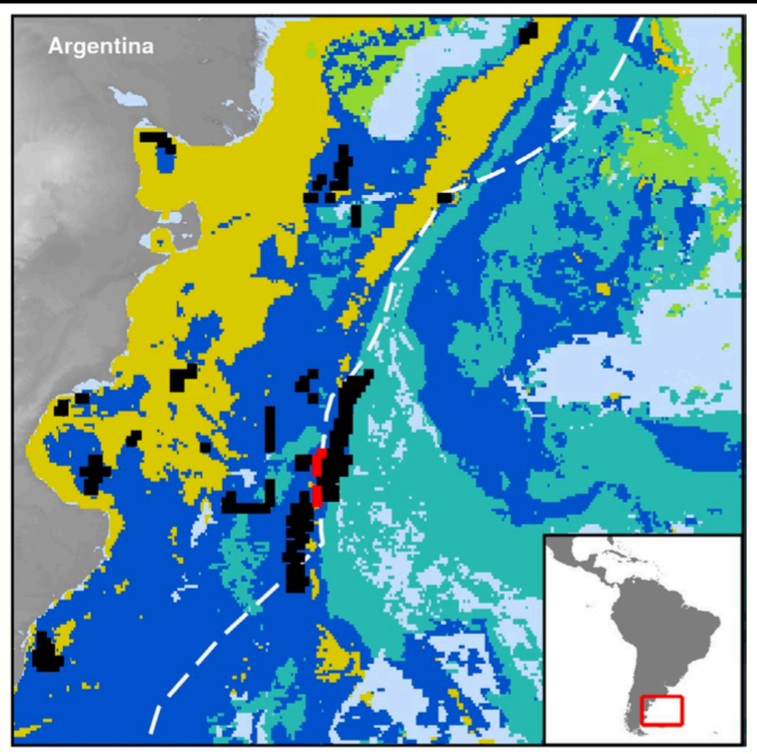
	Random forest	Random forest	Random forest	Random forest
	All variables	Top five variables	SEA, SST, CHL, month	All variables 2 km EEZ
	(1)	(2)	(3)	(4)
F-1 score				
2012	69%	84%	89%	92%

Good level of accuracy

Solution 3: Seascape Economics

“What gets measured gets managed”

NASA seascapes
(M. Kavanaugh)



Ecosystem-based management and the wealth of ecosystems

Seong Do Yun, Barbara Hutniczak, Joshua K. Abbott, and Eli P. Fenichel

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Edited by Partha Sarathi Dasgupta, University of Cambridge, Cambridge, United Kingdom, and approved May 11, 2017 (received for review October 24, 2016)

Eli Fenichel’s framework for quantifying the economic value of natural assets.

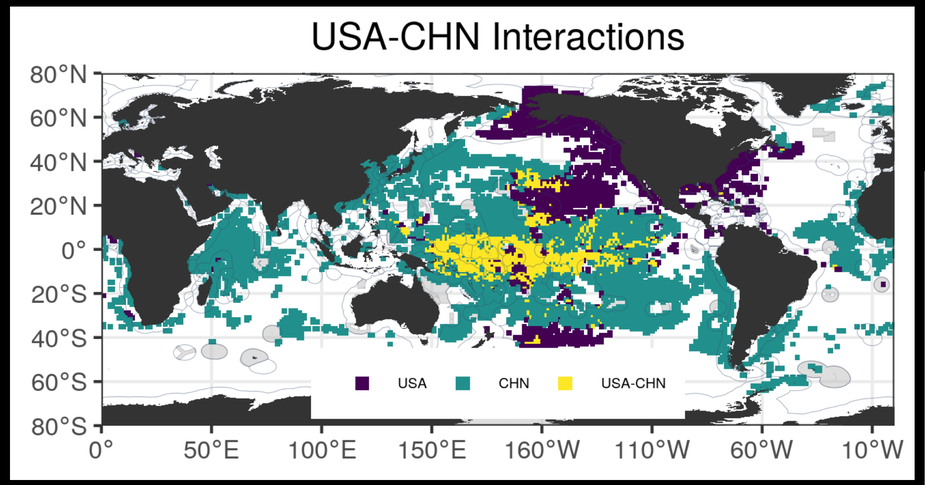
“Managing fisheries is managing people”
Ray Hilborn, 2007

~~PEOPLE~~ PROFIT

Solution 4: Who Harvests Where?

(And who gets along with who?)

The Cod Wars, when Iceland and the UK came into armed conflict over fish



Which nations rub shoulders when fishing?

GLOBAL FISHING WATCH

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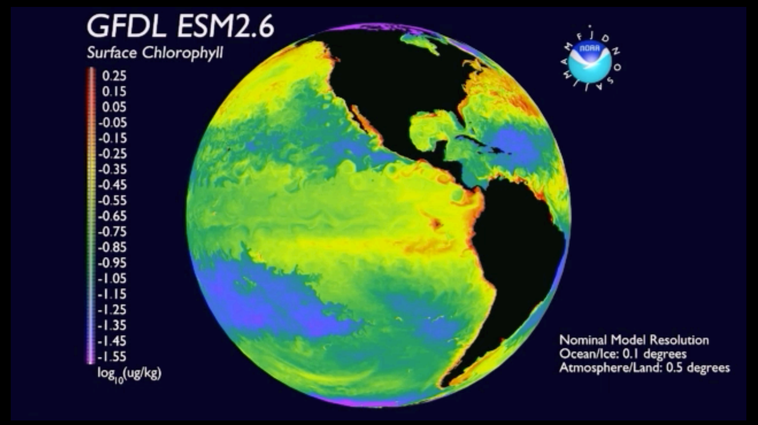
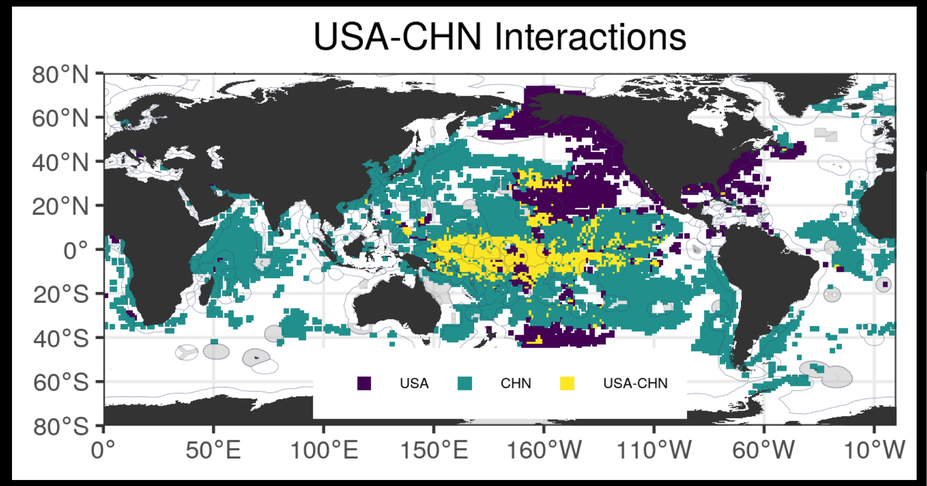
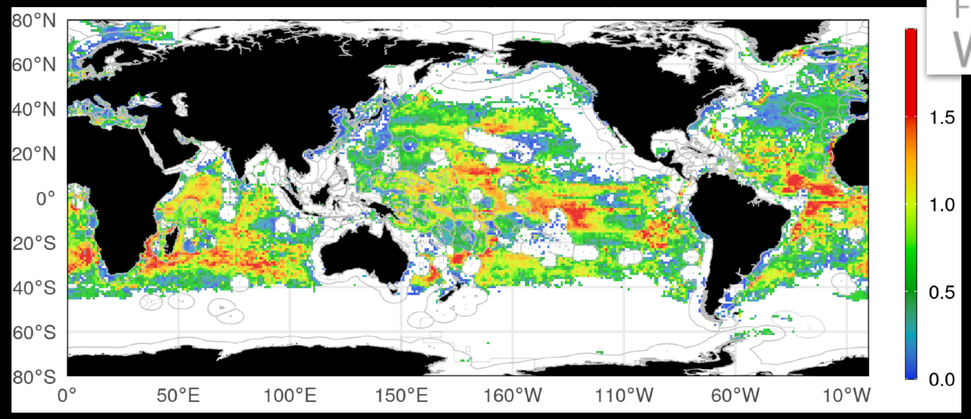






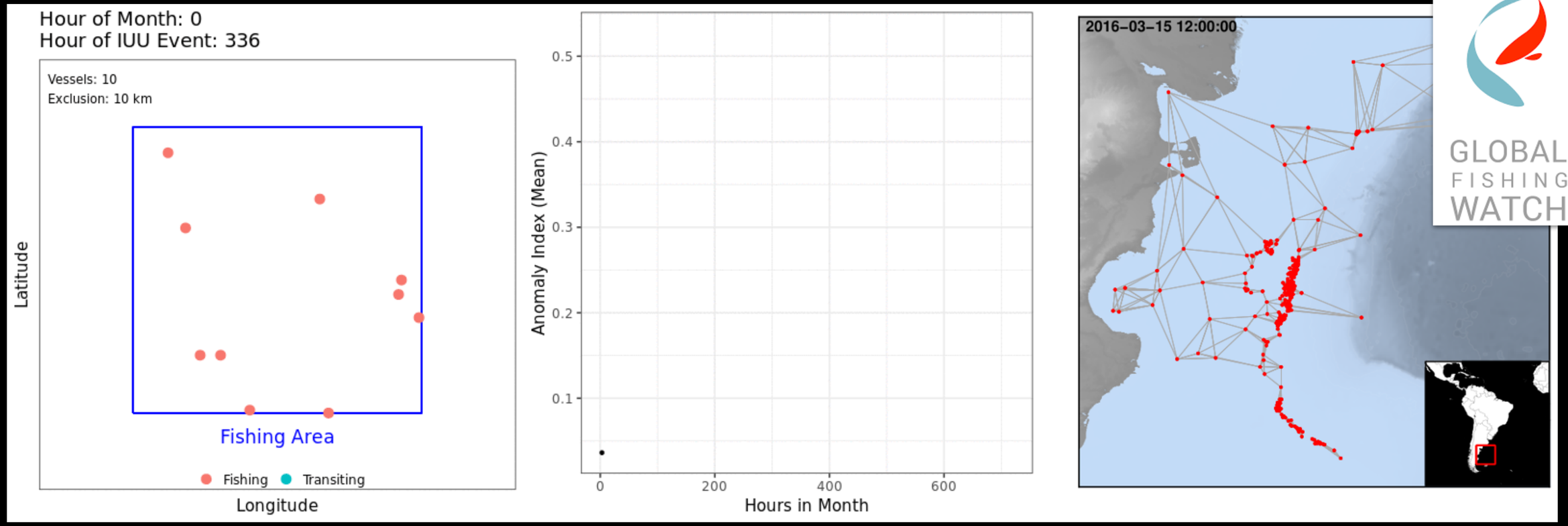
Fishing fleet Shannon diversity

Which nations rub shoulders when fishing?

GLOBAL FISHING WATCH

Nomura et al. In prep

Solutions: Complex Systems
(Spatial anomaly detection)



Watson & Woodill in review

This is an agent-based model of fishing vessels reacting to a nearby illegal activity.

What do we know now?

(That we didn’t know before)

- We have learned that certain oceanographic features such as fronts drive spatial patterns of fishing at small spatial scales
- We have learned about the scale-dependence of fishing on oceanographic drivers
- We have learned that oceanographic seascapes can predict illegal fishing, specifically incursions into EEZs, and we can quantify the economic value of whole seascapes
- We have learned who rubs shoulders with who on the high seas, and how this might change in the future.
- We learned how to anticipate illegal maritime activities from the anomalous response of observable vessels.

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NASA funded A.8 project: U.S. Patent Application No. 63/027,651

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esri

aeroterra

Argentinian Coastguard

US Coastguard

People Power
(Project Impact)

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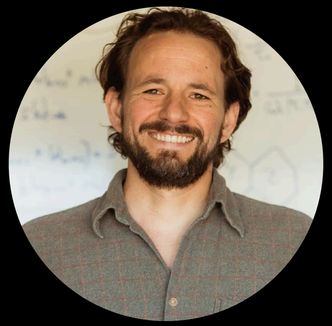

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SUSTAINABLE DEVELOPMENT GOALS